

## SECTION 03 3300 – CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

## 1.1 GENERAL PROVISIONS

- A. Requirements set forth herein are in addition to and shall be considered as complementary to the Terms and Conditions for Construction and the balance of Divisions 00 and 01 and Technical Specifications.
- B. All Contractors, Subcontractors, Vendors and the like shall be required to familiarize themselves with said provisions.

## 1.2 SUMMARY

- A. Work includes, but is not limited to, providing all labor, materials, equipment, and supervision to accomplish the following concrete work in accordance with the Drawings and Specifications:
  - 1. Construct reinforced concrete infill wall segments in brick wall, as indicated. Refer to Section 012300 ALTERNATES and Section 040305 CONSERVATION TREATMENT OF HISTORIC MASONRY WALL – ALTERNATE NO. 3
  - 2. Construct new reinforced concrete kneewalls at LMA Auditorium Pipe Rail, as indicated
  - 3. Construct new reinforced concrete wall caps, as indicated.
  - 4. Construct new reinforced concrete footings for bollards, light poles and other miscellaneous site features, as indicated.

## 1.3 RELATED WORK UNDER OTHER SECTIONS

- A. Related Requirements:
  - 1. Section 011000 SUMMARY OF WORK for load limitations specified by the Garage Structural Engineer of Record.
  - 2. Section 012300 ALTERNATES
  - 3. Section 013300 SUBMITTALS for general requirements.
  - 4. Section 024113 SELECTIVE SITE DEMOLITION
  - 5. Section 040305 CONSERVATION TREATMENT OF HISTORIC MASONRY WALL – ALTERNATE NO. 3
  - 6. Section 055200 MISCELLANEOUS SITE METALS
  - 7. Section 079200 JOINT SEALANTS.

## 1.4 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. Install: Operations at the project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

- C. Shop Drawing: Drawing or detail prepared by the Contractor, subcontractor, or supplier used to indicate the Contractor's understanding of the work or the Contractor's intended method of completing the work, for use by the Contractor, subcontractor, or supplier during fabrication, erection, installation, finishing, or otherwise performing the work, whether at the project site or at another location.

## 1.5 REFERENCES

- A. The following references are incorporated into these Specifications. These written Specifications take precedence over incorporated references. The Contractor shall have the following references at the project site at all times and shall be familiar with the reference contents.
  - 1. MassDOT (Massachusetts Department of Transportation)
    - a. Standard Specification for Highway and Bridges, latest editions, supplemental specifications, including all modifications, additions and deletions for the following:
    - b. Div II Section 901 Cement Concrete Masonry
    - c. Div III Section M4 Cement & Cement Concrete Materials
  - 2. ACI: American Concrete Institute
    - a. ACI 301 – ACI Specifications for Structural Concrete.
    - b. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
    - c. ACI 211.1R – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
    - d. ACI 305R – Hot Weather Concreting.
    - e. ACI 306R – Cold Weather Concreting.
    - f. ACI 308R – Standard Practice for Curing Concrete.
    - g. ACI 309R – Standard Practice for Consolidation of Concrete.
    - h. ACI 318 – Building Code Requirements for Reinforced Concrete.
    - i. ACI 347 – Recommended Practice for Concrete Formwork.
  - 3. ASTM International (ASTM):
    - a. ASTM C33 – Concrete Aggregates.
    - b. ASTM C94 – Ready Mix Concrete.
    - c. ASTM C150 – Portland Cement.
    - d. ASTM C260 – Air-Entraining Admixtures for Concrete.
    - e. ASTM C494 – Chemical Admixtures for Concrete.
    - f. ASTM E488 – Strength of Anchors in Concrete Elements
  - 4. CRSI – Placing Reinforcing Bars, Recommended Practices.

## 1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference Conducted at Project Site:
  - 1. Review methods and procedures related to concrete repairs, including but not limited to, the following:
    - a. Concrete mixture designs.
    - b. Quality control of concrete materials and mixtures.
  - 2. Require representatives of each entity directly concerned with concrete work to attend, including the following:
    - a. Owner.

- b. Owner's Representative(s).
  - c. Contractor's superintendent.
  - d. Concrete subcontractor
  - e. When requested by the Owner's Representative:
    - 1) Independent testing agency responsible for concrete design mixtures.
    - 2) Other trades involved to discuss the conduct of the work of this Section.
    - 3) Ready-mix concrete manufacturer.
- B. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishing, cold- and hot-weather concreting procedures, curing procedures, construction and isolation joints, forms and form removal limitations, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified flatness, flatness and measurement, and concrete protection.

#### 1.7 GUARANTEE

- A. Provide a written guarantee document stating that if, within 3 years after the Date of Substantial Completion of the Work, any of the work of this Section is found to be defective or not in accordance with the Specifications, the Contractor shall correct it promptly at no cost to the Owner. Also, it shall state that the Contractor shall bear all costs incurred by the Owner, including reasonable attorney's fees, to enforce compliance with the obligations of this Guarantee. The obligation of these Guarantees shall run directly to the Owner, may be enforced by the Owner against the Contractor, shall survive the termination of the Contract, and shall not be limited by conditions other than this Contract.

#### 1.8 ACTION SUBMITTALS

- A. Make all submittals in accordance with the requirements of Section 013300 SUBMITTALS.
- B. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.
- C. Submit the items listed in this section below to the Owner's Representative for approval in time to allow for review and resubmittals, if needed, without delaying the work. Do not order materials or start work before receiving the Owner's Representative's written approval for all submittals
- D. Product Data: For each type of product.
- 1. Manufacturer's Data Sheets.
  - 2. MSDS (SDS) Sheets.
- E. Concrete mix design for each type of concrete. The Contractor shall warrant by the submission of the design mixes that such mixes are totally representative of the concrete that he intends to supply to meet the requirements of the Contract Documents. Submit new design mixes for review and approval when any change in materials is required or needed. Include the following information for each concrete mix design:

1. Mix identification designation (unique for each mix submitted).
  2. Statement of intended use for mix.
  3. Method used to determine the proposed mix design.
  4. Compressive Strength at Seven and Twenty-Eight Days: Submit strength test records, mix design materials, conditions, and proportions for concrete used for record of tests, standard deviation calculation, and determination of required average compressive strength. The submission shall be in accordance with ACI 318.
  5. Gradation of Fine and Coarse Aggregates: Testing data confirming proposed coarse aggregate meets ASTM C33 class designation. Include ASTM test results for aggregates subject to freeze-thaw environment.
  6. Proportions of all ingredients, including all admixtures to be added either at the time of batching or at the jobsite.
  7. Water-to-cementitious-materials ratio.
  8. Slump tested in accordance with ASTM C143.
  9. Air content of freshly mixed concrete by the pressure method, ASTM C231, or the volumetric method, ASTM C173.
  10. Unit Weight of Concrete: ASTM C138.
  11. Written certifications of the following:
    - a. Mill test reports of portland cement chemical and physical analysis and certification of compliance with ASTM C150 Type I/II.
    - b. Mill test reports of fly ash chemical and physical analysis and certification of compliance with ASTM C618 Class C or F, if used.
    - c. Mill test reports of slag chemical and physical analysis and certification of compliance with ASTM C989, if used.
  12. Manufacturer's Spec Data Sheets of each concrete admixture, including brand name, manufacturer, and dosage rate range.
  13. Written certification of aggregate compliance with ASTM C33, including all restrictions on reactive materials, with the additional provision that the effectiveness of the use of a cement with less than 0.60% alkalis (sodium-oxide equivalent) or other mitigation methods shall be demonstrated by ASTM C1260, ASTM C1567, and/or ASTM C1293 testing or the aggregate shall have a demonstrated satisfactory performance history prior to acceptance.
- F. Concrete mixing, placement, sloping and grade control, curing, and protection procedures.
- G. Steel Reinforcement Shop Drawings: Provide drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Shop drawings shall be reviewed and approved Owner's Representative prior to fabrication.
- H. Concrete Placement Drawings: Drawing showing the layout and schedule of concrete placements; coordinate this drawing with the Joint Plan drawing, or show placement information on the Joint Plan drawing.
- I. Joint Plan: Drawing showing the layout and type of required joints, including isolation joints.

1. Location of construction joints is subject to approval of the Owner's Representative.

#### 1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Minutes of preinstallation conference.

#### 1.10 GENERAL PROCEDURES

- A. Work only in areas permitted by the Owner-approved schedule.
- B. Do not stockpile materials, debris, or equipment.
- C. Deliver materials to the site only in manufacturer's original containers, clearly marked with legible, intact labels with manufacturer's name and brand name and identifying contents of containers.
- D. Store materials in areas where temperatures and conditions conform to the manufacturer's recommendations and instructions.
- E. Replace materials damaged during handling or storage. Remove damaged materials from the premises immediately.
- F. Protect the existing utility systems or any systems that are to remain and to be in service during construction from all risks associated with the work in this Section. Schedule and execute all work without exposing the areas beyond the boundary of the construction to water, dust and debris, or materials used by this Contractor. Protect items described above from damage and stains with appropriate barriers and masking. Repair all damage as a result of the work of this Section to its condition at the start of work, or if such cannot be determined, to its original condition, at no cost to the Owner. Clean all stains by approved means.
- G. Protect the work from damage such as impact, marring of the surfaces, and other damage.
- H. Compliance with OSHA and all other safety laws and regulations is the exclusive responsibility of the Contractor, her/his subcontractors, suppliers, consultants, and servants.

#### 1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not place portland cement concrete when the base surface temperature is less than 40°F (4°C) unless all protections are in place in advance of temperature drop, as noted in this Section and in ACI 306R..

#### 1.12 QUALITY CONTROL AND QUALITY ASSURANCE

- A. Perform concrete work in accordance with the following, unless modified by requirements in the Contract Documents:

1. ACI 301 – Specifications for Structural Concrete.
  2. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
- B. Welding: Provide the following for each welded joint, all to comply with the requirements of AWS D1.1/D1.1M, "Structural Welding Code – Steel."
1. Welding Procedure Specifications (WPSs), Welder Qualification Records (WQRs), and Procedure Qualification Records (PQRs) for all welds.
- C. The Contractor shall conduct a quality control program that includes, but is not limited to, the following:
1. Inspection of all materials to ensure conformity to Contract requirements and that all materials are new and undamaged.
  2. Establishment of procedures for executing the work.
  3. Inspecting all reinforcement for placement in plan and elevation.
  4. Inspection of work in progress to ensure that work is being done in accordance with established procedures; manufacturer's instructions; specific Owner's Representative instructions, if given; or recommended practices as given in the references of Para. 1.3.
  5. Perform ASTM E488 testing for tensile and shear strength of post-installed and cast-in-place anchors as directed by the Engineer of Record, who shall determine the quantity of tests that shall be performed on anchors set in concrete. Perform the tests in the presence of the Engineer of Record. Contact the Engineer of Record no less than 3 working days prior to the test to schedule the testing.
- D. Qualifications:
1. The Contractor and its site superintendent shall have at least 5 years of experience supervising the installation of similar concrete specified in this Section.
  2. Installer Qualifications: All flatwork placement crews shall include personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
  3. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
    - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
1. Personnel conducting field tests shall be ACI-certified Concrete Field Testing Technician, Grade I, or an equivalent certification program.
  2. Personnel performing laboratory tests shall be ACI-certified Concrete Laboratory Testing Technician – Level 1. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Level 2.
- F. Quality Assurance Testing during Construction:

1. General: The Contractor shall employ an independent Testing Agency to perform tests and to submit test reports. The Contractor's Testing Agency shall conduct the following quality assurance tests at any time and location:
  - a. Sampling and testing of ready-mix concrete for slump, air content, and seven- and twenty-eight-day compressive strengths.
  - b. Examining new concrete for any defective work, such as cracking, honeycombing, etc.

G. Preinstallation Conference:

1. Attend a preinstallation conference to be held with a representative of the Owner, Owner's Representative, General Contractor's field superintendent, foreman, and other trades involved to discuss the conduct of the Work of this Section.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement

1.14 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40°F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
4. Protection against cold weather, including concrete mixture acceleration, insulation, heat systems, enclosures, or a combination of all such practices shall be planned for well in advance of concrete placement. Maintain protection measures in place until minimum compressive strength has been achieved.

- B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90°F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided that the water equivalent of the ice is included in the total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist, without standing water, soft spots, or dry areas

## PART 2 - PRODUCTS

## 2.1 FORM MATERIALS

- A. Earth Forms: Earth forms will not be permitted for vertical surfaces.
- B. Exposed-to-View Surfaces:
  - 1. Use new Class 1 B-B High Density Overlaid Plyform, exterior grade, not less than five ply nor less than 5/8 inch thick conforming to U.S. Product Standard P-1-83. Design and maintain forms in accordance with instructions in American Plywood Association (APA) Manual "Concrete Forming" (Form No. V345N/Revised June 87/5000).
  - 2. Cylindrical Columns and Supports: Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
- C. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- D. Not-exposed-to-view Concrete Surfaces: Use forms of wood, metal, or other material subject to approval of Owner's Representative.
- E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 in., minimum. Nailed six inches on center and installed in inside corners of all forms, unless otherwise indicated or otherwise directed by the Owner's Representative.
- F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
  - 3. Ties for concrete exposed to public view shall have removable set-back cones.
  - 4. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- H. Where indicated, isolation and expansion joint filler shall be ANSI/ASTM D1752 preformed sponge rubber or cork, 1/2 in. thick.



## 2.2 CONCRETE MATERIALS

- A. Portland cement: ASTM Specification C150, Type I/II, Grey or White, of same type, brand, and source. Use only one brand of cement for each type of cement throughout project. No visual variations in color shall result in exposed concrete.
- B. Fly Ash: ASTM C618, Class F.
- C. Slag: ASTM C989, Grade 100 or 120.
- D. Normal-Weight Aggregates:
  - 1. Sand shall consist of washed, clean, hard, uniformly graded natural silica sand in accordance with ASTM C33.
  - 2. Coarse aggregate shall be nominal 3/4 inch maximum size, with distribution per ASTM C33, Table II, clean, and well graded.
  - 3. All aggregate shall be certified by the supplier as being nonreactive in accordance with ASTM C1260, ASTM C1567, and/or ASTM C1293 or shall have a demonstrated satisfactory performance history.
- E. Water: Clean, potable water, free of contaminants and in conformance with the requirements of ASTM C94.
- F. Admixtures: Provide admixtures that are certified by the manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete, with written documentation. Do not use calcium chloride or admixtures containing calcium chloride. All admixtures must be approved in writing by the Owner's Representative prior to use. Manufacturer(s) approval for the use of all admixtures in combination must be submitted to the Owner's Representative prior to use.
  - 1. Air-entraining admixture: shall comply with ANSI/ASTM C 260.
    - a. "Daravair", W.R. Grace & Co.
    - b. "Airmix or Perma-Air", The Euclid Chemical Co.
    - c. "MB-VR", Master Builders Co.
    - d. Or approved equivalent.
  - 2. Silica fume admixture: shall be supplied in slurry form as one of the following and in strict accordance with manufacturer's instructions; use water-fog misting or evaporation retarder immediately after floating flatwork containing silica fume:
    - a. "Force 10,000", W.R. Grace & Co.
    - b. "MB-SF", Master Builders.
    - c. "Sikacrete 950", Sika Corp.
    - d. Or approved equivalent.
  - 3. Evaporation retarder: use water-based monomolecular film; use one of the following with flatwork containing corrosion inhibitor or silica fume admixture:
    - a. "Confilm", Master Builders.
    - b. "Euco-bar", Euclid Chemical Co.
    - c. "E-Con", L & M Construction Chemicals
    - d. Or approved equivalent.
  - 4. Water-reducing admixture: Shall comply with ANSI/ASTM C494, Type A and contain no more than .05% chloride ions.

- a. "WRDA with Hycol", W.R. Grace & Co.
  - b. "Eucon WR-75", The Euclid Chemical Co.
  - c. "Pozzolith 220N", Master Builders Co.
  - d. Or approved equivalent conforming to ASTM C494.
5. Accelerator admixture: Non-chloride and non-corrosive accelerators shall conform to ASTM C494 Type C and may be used when temperatures are below 50 degrees F. Use one of the following or equivalent:
  - a. "Daraset"; W.R. Grace
  - b. "Accelguard 80"; Euclid Chemical Co.
  - c. "Pozzutec 20"; Master Builders.
6. Water-reducing Set Retarders: shall conform to ASTM C494 Type D and may be used when ambient temperatures exceed 80 degrees F. Use one of the following or equivalent:
  - a. "Daratard-17"; W.R. Grace.
  - b. "Eucon Retarder"; Euclid Chemical Co.
  - c. Pozzolith 100-XR"; Master Builders.
7. Corrosion Inhibitor admixture: calcium nitrite based inhibitor shall comply with AASHTO M194 Type C, such as W.R. Grace "DCI Corrosion Inhibitor" or approved equivalent at the rate of 3.0 gallons per cubic yard of concrete. Use water-fog misting or evaporation retarder immediately after floating flatwork containing corrosion inhibitor.

## 2.3 REINFORCEMENT

- A. Unless otherwise noted in the Contract Documents, reinforcing bars shall conform to ASTM A615, Grade 60, deformed. Bars shall be bent cold.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete. Use plastic tips on all chairs in contact with concrete formwork.
- C. Tie Wire: No. 16 gauge annealed, plastic coated.
- D. Epoxy-coated reinforcing: provide epoxy coating on all reinforcing bar steel and welded wire fabric after fabrication in compliance with ASTM A-775. Inspect epoxy coated reinforcing for compliance with ASTM A-775 and tag the reinforcing with the name of the epoxy facility, the ASTM number and coating thickness. A notarized Certificate of Compliance with all of the above shall be required from the epoxy facility. In accordance with CRSI Engineering Data Report No. 19, use special procedures during handling, storage and installation to prevent scarring epoxy coating.
- E. Reinforcement Accessories: Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. Tie wire shall be annealed wire of sufficient strength for intended purpose, but not less than No. 18 gage. Bar supports shall conform to Chapter 3, "Bar Supports" or CRSI Manual of Standard Practice. Supports touching interior formed surfaces exposed to view shall be CRSI Class 1, plastic protected. When epoxy coated reinforcing is used, accessories shall be epoxy coated and tie wire shall be nylon, epoxy or plastic coated.

## F. Adhesive for Reinforcing Bar Dowels and Adhesive Anchors:

1. Hilti HIT-HY 200 Epoxy Adhesive, Hilti, Inc., Tulsa, Oklahoma.
2. Approved Equivalent.

## G. Expansion Anchors: Hot-dipped galvanized anchor bolt and sleeve assembly, conforming to Federal Spec. FF-S-325, Group II, Type 4, Class 1, with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Hilti Kwik Bolt TZ, Hilti, Inc., Tulsa, Oklahoma.
2. Or approved equivalent.

## H. Stainless-Steel Bolts and Nuts: Hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2, 316.

## 2.4 JOINTING MATERIALS

- A. Expansion Joint Filler: ANSI/ASTM D1752 preformed sponge rubber or cork, 1/2 in. (12 mm) thick.
- B. Joint Sealants as specified in applicable Division 07 Sections.

## 2.5 RELATED MATERIALS

- A. Non-shrink Grout: Use CRD-C 621, factory pre-mixed grout, Type D, non-metallic, such as one of the following or an approved equivalent:
1. "Masterflow 928"; Master Builders.
  2. "Euco-NS"; Euclid Chemical Co.
  3. "Five Star Grout"; Five Star Products.
- B. Absorptive Cover: Use burlap cloth weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- C. Moisture-Retaining Cover: One of the following, complying with ASTM C171:
1. Polyethylene-coated, blended polyester fabric.
    - a. HydraCure Wet Curing Cover, PNA Construction Technologies, Inc., 9 Dunwoody Park, Suite 111, Atlanta, GA 30338.
    - b. Or approved equivalent.
  2. Polyethylene film.
  3. Polyethylene-coated burlap.
  4. Use of curing compounds is strictly prohibited.
- D. Curing Compounds: Verify that products listed below meet regulations of jurisdiction for Volatile Organic Compounds (VOC) emissions. Notify Owner's Representative if listed products do not comply and submit information about equivalent products that do comply.

1. Curing and Sealing Compound: Use a clear acrylic type conforming to ASTM C309, Type I, Class B. Use one of the following or equivalent where concrete surfaces will remain exposed. a. "Masterkure"; Master Builders. b. "Super Rez Seal"; Euclid Chemical Co. c. "Dress & Seal #30"; L & M
  2. Curing and Hardening Compound: Use colorless solution containing 35% of a 42 degree Baume sodium silicate solution. Use where shown on drawings. Use one of the following or equivalent: a. "Chem-Hard"; L & M b. "Eucosil" Euclid Chemical Co. c. "Cure-hard"; W.R. Meadow
  3. Dissipating Resin Curing Compound: Use a dissipating resin type compound, conforming to ASTM C309, Type I. The film must chemically break down in a two-to-four week period. Use one of the following or equivalent where concrete surfaces will receive other materials: a. "Kurez DR"; Euclid Chemical Co. b. "3100"; W.R. Meadows c. "Cure Resin"; L & M
- E. Bonding Agent, Patching Mortar: Cementitious slurry containing polymer-modified latex admixture, such as one of the following:
1. "SikaTop 121, 122 or 123"; Sika Corporation
  2. "Flexcon"; Euclid Chemical Co.
  3. "Everbond"; L & M

## 2.6 MIX PROPORTIONS

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301 and ACI 318. For the trial batch method, use an independent testing agency acceptable to Owner's Representative for preparing and reporting proposed mix designs.
1. Do not use the same testing agency for field quality-control testing.
  2. Submit written reports to the Owner's Representative of each proposed mix for each class of concrete at least fifteen days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed and approved by the Engineer of Record.
- B. Design mixes to provide normal-weight concrete with the following properties as indicated on Drawings and schedules:
1. Total Cementitious Content: 725 lbs/cu yd, maximum.
    - a. If a low-alkali cement is used to address potential aggregate reactivity, its effectiveness shall be demonstrated by testing according to ASTM C1567.
    - b. Limit use of fly ash in concrete exposed to deicing chemicals in service to not exceed 25% of cement content by weight. If fly ash contents above 25% are required for reactive aggregate mitigation, provide ASTM C666 testing results indicating satisfactory performance.
    - c. Limit use of slag in concrete exposed to deicing chemicals in service to not exceed 50% of cement content by weight. If fly ash contents above 25% are required for reactive aggregate mitigation, provide ASTM C666 and ASTM C672 testing results indicating satisfactory performance.
  2. Limit water-soluble, chloride-ion content in hardened concrete to 0.15% by weight of cement.
  3. Twenty-Eight-Day Design Compressive Strength: 5,000 psi.

4. Air Content: Total 6-1/2% with a tolerance of  $\pm 1\text{-}1/2\%$  (5% to 8%) based on 3/4 inch maximum-sized aggregate. If another coarse-aggregate size is used, the air content will need to be adjusted to meet minimum air contents as identified in ACI 318 for severe exposure.
  5. Slump Limits: 5 to 7 in.
  6. Water to Cementitious Materials Ratio: W/CM shall be 0.40 or less.
  7. Corrosion Inhibitor: The concrete shall contain a dosage of 1.0 gal/cu yd of corrosion inhibitor.
  8. Do not use calcium chloride.
  9. Use accelerating admixtures in cold weather only when approved by the Owner's Representative. Use of admixtures will not relax cold-weather placement requirements.
  10. Use set-retarding admixtures during hot weather only when approved by the Owner's Representative.
- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Owner's Representative. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Owner's Representative before using in Work.
- D. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.
1. When air temperature is between 85-degrees and 90-degrees Fahrenheit, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90-degrees Fahrenheit, reduce mixing and delivery time to 60 minutes.
  2. Provide a batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.
- E. Concrete shall be vibrated and compacted properly to ensure it can flow freely around the reinforcement and into the formwork without creating areas of honeycombing, segregation, or incomplete filling.
- 2.7 EQUIPMENT
- A. Pumping Equipment:
1. The pump for placing the concrete shall be compatible with the material being placed, sized to the quantity of material being installed at any one time, and available for use when needed. All pumping equipment shall have adequate controls to regulate flow rates.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine work prepared by other trades to receive work of this Section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
- B. Notify the Owner's Representative immediately and in writing of any discrepancies between the Drawings and field conditions or of incompatibilities with the desired grades, specified thicknesses, and existing elevation constraints. Do not start work until all discrepancies and incompatibilities have been resolved.

## 3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS

- A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.

## 3.3 REINFORCEMENT AND DOWELS

- A. Install reinforcement and dowels as indicated in the Contract Drawings.
- B. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- D. Accurately position, support, and secure reinforcement and dowels against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars. Use "sand feet" or equivalent protection under all reinforcing bar supports to prevent damage to underlying materials.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Install epoxy anchors in accordance with the manufacturer's recommendations at locations shown on Contract Drawings.
- G. Place reinforcement in accordance with ACI 117 (Tolerances) and with Contract Documents and secure firmly in position by wire ties, chairs, spacers, and hangers, each of type approved by Owner's Representative.
- H. Welding Reinforcement: Comply with AWS D1.4-98 for welding practices. Preheat and interpass temperatures shall comply with Table 5.2 of AWS D1.4-98. Provide mill reports to Owner's Representative showing carbon content of reinforcing being welded.
- I. Do not bend, tack-weld or cut reinforcement in field in any manner other than as shown on Drawings unless specific approval for each case is given by Owner's Representative.

- J. Continue reinforcement through construction joints unless otherwise indicated on Drawings.
- K. Splice reinforcement only in accordance with requirements of Contract Documents or as otherwise specifically approved by Owner's Representative. Do not splice reinforcement at points of maximum stress unless shown on the Drawings. Welded wire fabric shall be lapped six inches or one and one-half spaces, whichever is larger, and shall be wired together.
- L. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond. Paint reinforcement expected to be exposed to weather for a considerable length of time with a heavy coat of cement grout. Protect stored materials so as not to bend or distort bars in any way. Bars that become damaged will be rejected. Repair damage to coating of epoxy coated rebars in strict accordance with epoxy manufacturer's published instructions.
- M. Before concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Documents and approved Shop Drawings. Such checking shall be done only by qualified experienced personnel. In addition, notify the Owner's Representative at least 36 hours prior to concrete placement so a visit may be made to observe completed reinforcement and formwork before concrete placement.

#### 3.4 TOLERANCES

- A. Slope the surface of the new concrete paving slab in accordance with the Contract Drawings. All sloped surfaces shall positively drain.
- B. Remedial work necessary for correcting construction not conforming to specified tolerances is the responsibility of the Contractor. Erected work that does not meet specified tolerance limits shall be remedied or removed and replaced at Contractor's expense.
- C. If not otherwise indicated, provide minimum concrete surface flatness of  $FF = 30$ , when measured according to ASTM E1155.
- D. Surface elevations shall have a tolerance of  $\pm 1/4$  in.

#### 3.5 FORMWORK

- A. Design, construct and remove formwork, shoring and bracing to meet design requirements so that resultant concrete conforms to required shapes, lines and dimensions.
- B. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until the structure can support such loads.
- C. Construct formwork so that concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

- D. Construct forms tight enough to prevent loss of concrete mortar. At construction joints, overlap and clamp forms (using gaskets if necessary) to prevent offsets or loss of mortar at joints.
  - E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
    - 1. Install keyways, reglets, recesses, and the like for easy removal.
    - 2. Do not use rust-stained steel form-facing material.
  - F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
  - G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
  - H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
  - I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete. Before reusing form materials, thoroughly clean surfaces that will be in contact with freshly cast concrete, repair damaged areas and withdraw projecting nails. Recoat form with release agent. Reuse of form material for architecturally exposed concrete shall be subject to approval by Owner's Representative.
  - J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
  - K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
  - L. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes or coverings that may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.
- 3.6 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE
- A. Use ready-mixed concrete produced by plant acceptable to Owner's Representative. Hand or site mixing shall not be done. Batch constituents, including admixtures, at central plant. Admixtures shall be premixed in solution form and dispensed as recommended by manufacturer.
  - B. Concrete shall arrive at the job site at a slump of 2 to 3 inches and at the time of deposit shall be as follows:



1. If high-range water reducing admixture (superplasticizer) is used, it may be added at the job site after verifying that the delivery slump is 2 to 3 inches. Maximum slump after adding HRWR shall be 8 inches.
  2. For normal weight concrete, water may be added at the site only to make up water withheld at the plant. Batching plant shall document on the driver's delivery ticket any water withheld at the plant. When water has not been withheld and slump is too low for proper handling of concrete, use HRWR to bring slump within specified range.
- C. Transport ready mixed concrete to site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Discharge at site within one and one-half hours after cement was first introduced into mix. Do not use concrete with a temperature greater than 85 degrees Fahrenheit. Central mixed concrete shall be plant mixed a minimum of five minutes. Agitation shall begin immediately after premixed concrete is placed in truck and shall continue without interruption until discharged. Transit mixed concrete shall be mixed at mixing speed for at least ten minutes immediately after charging truck followed by agitation without interruption until discharged.
- D. Do not retemper (mixing with or without additional cement, aggregates, or water) concrete which has partially hardened.

### 3.7 REMOVING AND REUSING FORMS

- A. General: Formwork for Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after concrete placement. Concrete shall be hard enough not to be damaged by form-removal operations, and curing and protection operations must be maintained.
- B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 80% of its twenty-eight-day design compressive strength.
- C. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- D. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- E. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Owner's Representative.

### 3.8 JOINTS

- A. General: Construct joints true to line with faces perpendicular to the surface plane of the concrete.
- B. Construction Joints: Install so that strength and appearance of concrete are not impaired, at locations indicated or as approved by Owner's Representative.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
3. Use a bonding grout at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

### 3.9 OPENNINGS

- A. Openings for passing through concrete: Contractor shall establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections. Contractor shall be held responsible for proper coordination of all work of this nature in order that there will be no unnecessary cutting and patching of concrete. Any cutting and repairing to concrete required as a result of failure to provide for such openings shall be paid for by the Contractor at no additional expense to the Owner.

### 3.10 INSTALLATION OF EMBEDDED ITEMS

- A. Conform to requirements of ACI-318, paragraph 6.3, "Conduits and Pipes Embedded in Concrete", and as specified below.
- B. Install steel sleeves, furnished by other trades, at locations shown on the drawings.
- C. Install anchor bolts for column baseplates in accordance with AISC Code of Standard Practice, Paragraph 7.5 and the following: Use setting plate templates. Maintain elevations and plan locations of bolt groups within one-quarter inch of the locations shown on the drawings. Place individual bolts in a bolt group within one-eighth inch of center-to-center dimensions shown on the drawings.

### 3.11 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless water is held back at the batch plant and the amount of water held back is indicated on the batch ticket. Do not add more water than the amount that is indicated on the batch ticket as being held back. Any such water shall be added before test sampling and placement of concrete.
- C. Remove water and foreign matter from forms and excavations and, except in freezing weather or as otherwise directed, thoroughly soak wood forms just prior to placing concrete. Place no concrete on frozen soil and provide adequate protection against frost action during freezing weather.
- D. To secure bond at construction joints, thoroughly clean concrete surfaces with water jet or compressed air. Before new concrete is deposited, saturate joint surface with water.

- E. Do not place concrete having slump outside of allowable slump range. The loss of slump between pump and discharge end of pipeline shall not exceed two inches.
- F. Transport concrete from mixer to place of final deposit as rapidly as practical by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid re-handling. Deposit no partially hardened concrete. When concrete is conveyed by chutes, equipment shall be of such size and U-shaped design as to insure continuous flow in chute. Do not use flat (coal) chutes. Use metal or metal lined chutes with different portions having approximately the same slope. Slope shall not be less than 25 degrees nor more than 45 degrees from horizontal. Use a baffle or spout at the discharge end of the chute to prevent segregation. If discharge end of chute is more than five feet above surface of concrete in forms, use spout with its lower end at surface of deposit. When operation is intermittent, discharge chute into hopper. Do not allow concrete to flow horizontally over distances exceeding five feet.
- G. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete so as to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth so as to not exceed formwork design pressures and in such a manner as to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. During and immediately after depositing, compact concrete in accordance with ACI 309 by means of internal type mechanical vibrators or other tools to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on only enough to produce homogeneity and optimum consolidation without permitting segregation of constituents or "pumping" of air. Vibrators used for normalweight concrete shall operate at speed of not less than 7,000 rpm and be of suitable capacity. Do not use vibrators to move concrete. Keep at least one vibrator on hand for every 10 cubic yards of concrete placed per hour, plus one spare. Vibrators shall be operable and on site prior to starting placement.
  - 4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate the placed layer and at least 6 inches into the preceding layer to limit the appearance of pour liens. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- H. Deposit and consolidate concrete in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Slope surfaces uniformly to drains where required.

- I. Cold joints, particularly in exposed concrete, including "honeycomb", are unacceptable. If they occur in concrete surfaces exposed to view, Owner's Representative will require that entire section in which blemish occurs be removed and replaced with new materials at Contractor's expense.
- J. When placing exposed concrete walls or columns, strike corners of forms rapidly and repeatedly from outside along full height while depositing concrete and vibrating.
- K. Clean chutes, hoppers, spouts, adjacent work, etc. before and after each run; discharge water and debris outside form.
- L. Follow ACI recommendations for Hot Weather Concreting (ACI 305R) and Cold Weather Concreting (ACI 306R) as required by ambient conditions.

### 3.12 FINISHING FORMED SURFACES

#### A. Finish of Formed Surfaces:

- 1. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work. This is the concrete surface imparted by stock form facing material used with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼" in height rubbed down or chipped off.
- 2. Smooth Form Finish: For formed concrete surfaces exposed-to-view and surfaces that are to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing paint. This is the as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of joints and with a systematic pattern of ties with set-back cones. Grout tie holes; remove and rub smooth fins or other projections. Surfaces remaining exposed-to-view shall have uniform color and texture acceptable to the Owner's Representative.
- 3. Related Unformed Surfaces: At tops of walls, horizontal offsets surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- 4. Rubbed Finish: Apply the following finish to smooth-formed-finished as-cast concrete where indicated:
  - a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

### 3.13 FINISH FOR WALLS

#### A. Walls:

- 1. After screeding, consolidating, and leveling concrete, do not work surface until ready for floating. Begin floating when surface water has disappeared and when concrete has stiffened sufficiently to hand float. Check and level surface plane to a tolerance not exceeding 1/4-inch in 10-feet when tested with a 10-foot straightedge. Uniformly slope surface to drain.
- 2. Walls:

- a. For horizontal, exposed-to-view tops of walls (or for horizontal wall surfaces to be covered with membrane or elastic waterproofing): apply float finish to top of wall prior to final trowel finish.
- b. Apply trowel finish to horizontal tops of walls. After floating, consolidate concrete surface by final hand-troweling operations, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance no exceeding 3/16-inch in 10-feet, when tested with a 10-foot straightedge.

### 3.14 CONCRETE PROTECTING AND CURING

- A. Cure concrete in accordance with the recommendations of the ACI Manual for Concrete Practice using only moist curing procedures specified in Para. 5.3.6 of ACI 301. Submit proposed curing procedures to Owner's Representative for approval prior to use.
- B. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Where corrosion inhibitor or silica fume admixture have been used, provide continuous water-fog spray or mist or evaporation retardant to prevent plastic shrinkage cracks during initial setting time.
- C. Start curing before concrete has dried and immediately after placing and finishing. Keep concrete moist for at least seven days after casting. Cover with wet burlap and polyethylene and keep well drained while maintaining a damp condition continuously. Fog-spray concrete during the curing period as frequently as drying conditions may require.
- D. Formed Surfaces: Cure formed concrete surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, and other surfaces.
- F. During curing period, maintain concrete above 70°F for at least two days. Provide heated curing blankets if needed.
- G. Curing Methods: Keep concrete surface continuously wet by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.
  1. Provide moisture curing by any of the following methods at Contractor's option:
    - a. Covering with water.
    - b. Continuous water-fog spray.
    - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
  2. Provide moisture-cover curing as follows:
    - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Provide curing compound as follows:
  - a. Apply specified curing compound to exterior and exposed interior concrete slabs as soon as final finishing operations are complete (within 2 hours) and to formed surfaces immediately after forms are removed.
  - b. Apply uniformly in two continuous operations at right angles to each other by powerspray or roller in accordance with manufacturer's directions. Re-coat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
  - c. Use dissipating resin type curing compounds on surfaces which are to be covered with finish or coating material applied directly to concrete, such as liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials. If curing compound is not compatible with coating materials, moisture or moisture-cover curing shall be used.
- H. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
  1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  2. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- I. Hot weather placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
  1. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  2. Wet forms thoroughly before placing concrete.
- J. Keep permanent temperature record showing date and outside temperature for concreting operations. Take thermometer readings at start of work in morning, at noon, and again late in afternoon. Record locations of concrete placed during these periods so any effect temperatures may have had on construction can be correlated. Distribute copies of temperature record daily to Owner's Representative.
- K. Protect concrete against rapid drying and damage by rain and/or frost. Appearance of plastic shrinkage cracks may be cause for rejection of the concrete and shall be repaired or replaced at Contractor's expense.
- L. Protect all concrete work against damage and defacement during subsequent construction operations until final acceptance and full cure.
- M. For patching and filling, comply with ACI 301, Chapter 5, and if premixed repair materials are used, the material manufacturer recommendations.

**3.15 REMOVAL OF FORMWORK, SHORING AND RESHORING**

- A. Contractor shall be responsible for proper removal of formwork shoring, and re-shoring. Comply with
  - 1. ACI 347 for shoring and re-shoring in multi-story construction.
- B. Remove vertical forms as soon as concrete has attained sufficient strength to support its own weight and their removal can be done without damage to the concrete. Apply curing compound immediately after removing forms.
- C. Keep horizontal forms and supports in place for not less than minimum periods of time noted below or until concrete has reached 60 percent of its specified strength.
  - 1. Soffits of beams or girders shall remain in place until concrete has attained 600 day-degrees.
  - 2. Forms of floor slabs shall remain in place until concrete has reached 400 day-degrees.
  - 3. Definition of day-degrees: Total number of days or fractions of days times mean daily air temperature at surfaces of concrete; where concrete surface is protected by insulated blankets or formwork, temperature may be taken under the blankets or formwork. For example, five days at temperature of 60 degrees F. equals 300 day degrees. Days or fractions of days in which temperature is below 50 degrees F. shall not be included in calculation of day-degrees.
- D. When forms are removed, place reshores at same time as stripping operations so that no unshored area is larger than one-fourth of a slab panel. Allow no live load on slab when stripping and shoring are being done.
- E. Field cure test cylinders under same conditions as concrete they represent in order to verify minimum strengths for form removal. Such cylinders and testing shall be at the Contractor's expense.

**3.16 JOINT FILLING**

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
  - 2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
  - 3. Install joint filler full depth in saw-cut joints and at least 2 in. (50 mm) deep in formed joints.
  - 4. Install compressible filler full depth in expansion joints.

**3.17 REMOVAL OF FORMWORK, SHORING AND RESHORING**

- A. Contractor shall be responsible for proper removal of formwork shoring, and re-shoring. Comply with
  - 1. ACI 347 for shoring and re-shoring in multi-story construction.

- B. Remove vertical forms as soon as concrete has attained sufficient strength to support its own weight and their removal can be done without damage to the concrete. Apply curing compound immediately after removing forms.
- C. When forms are removed, place reshores at same time as stripping operations so that no unshored area is larger than one-fourth of a slab panel. Allow no live load on slab when stripping and shoring are being done.
- D. Field cure test cylinders under same conditions as concrete they represent in order to verify minimum strengths for form removal. Such cylinders and testing shall be at the Contractor's expense.

### 3.18 TESTING

- A. Testing and Inspecting: The Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports. Contractor shall provide all required support for testing, including samples of concrete, power for heating/cooling of samples during initial curing, and storage location adjacent to the area of work.
- B. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Steel reinforcement welding.
  - 3. Headed bolts and studs.
  - 4. Chemical anchor system.
  - 5. Verification of use of required design mixture.
  - 6. Concrete placement, including conveying and depositing.
  - 7. Flatness testing.
- C. Curing procedures and maintenance of curing temperature.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain one composite sample for each day's placement of each concrete mixture exceeding 5 cu yd, but less than 25 cu yd, plus one set for each additional 50 cu yd or fraction thereof of each concrete mixture placed each day.
  - 2. Slump: ASTM C143/C143M; one test at point of discharge for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C231, pressure method, for normal-weight concrete; one test at point of discharge for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40°F (4.4°C) and below and when 80°F (27°C) and above, and one test for each composite sample.
  - 5. Unit Weight: ASTM C138 whenever air content is measured.
  - 6. Compression Test Specimens:
    - a. ASTM C31; one set of eight standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for



- laboratory-cured test specimens except when field-cured test specimens are required.
- b. ASTM C39; one set for each day's placement of each concrete mixture exceeding 5 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards or fraction thereof of each concrete mixture placed each day.
  - c. Sample plastic concrete for testing in accordance with ASTM C172 and mold cylinders per ASTM C31.
  - d. Cure test specimens for twenty-eight-day-strength verification per ACI 301, Chapter 16.
  - e. Compression Tests:
    - 1) Test three cylinders at seven days.
    - 2) Test three cylinders at twenty-eight days.
    - 3) Hold two cylinders in reserve for use as the Owner's Representative directs.
    - 4) After fifty-six days, unless notified by the Owner's Representative to the contrary, reserve cylinders may be discarded without being tested for specimens meeting twenty-eight-day-strength requirements.
7. Flatness Testing: meeting requirements described in this section.
  8. Test results will be reported in writing to the Owner, Owner's Representative, Ready-Mix Producer, and Contractor within 24 hours after tests. Include the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight days, concrete mix proportions and materials, compressive breaking strength, and type of break for both seven-day tests and twenty-eight-day tests.
    - a. If the concrete does not meet the requirements listed above, the concrete shall be rejected, removed, and replaced at the Contractor's expense.
    - b. When strength of field-cured cylinders is less than 85-percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
    - c. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
  9. Nondestructive Testing: Rebound hammer, impact-echo, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
  10. Additional Tests: The Testing Agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Owner's Representative. The Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed.
- E. Visual Inspection of Concrete Surface of Newly Placed Concrete:
1. Visually examine the entire exposed new concrete exposed to view surfaces.
- F. Additional testing and inspecting, at the Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- G. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents at no cost to the Owner.
  - 1. Appearance of unconsolidated or honeycombed concrete shall be cause for rejection of the work so affected. Rejected concrete shall be removed and replaced at Contractor's expense.
  - 2. Omission of chamfered edges in formed underside repairs shall be cause for rejection of the work so affected.

### 3.19 ACCEPTANCE AND REPAIRING OF CONCRETE SURFACES

- A. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes.
  - 1. Remove and replace architectural concrete with surface defects exceeding the limitations of ACI 301, Section 13.3.1 or having honeycombs, excessive air voids (bugholes), mismatched coloring, pour lines or sand streaking. The standard of acceptability shall be the surface quality of the approved test panel; or, where no test panel has been made, the standard of unacceptability shall be the photographs shown with paragraphs 7.6 and 7.7 or ACI 309R-96 "Guide for Consolidation of Concrete".
  - 2. Where patching is acceptable to Owner's Representative, procedure shall comply with ACI 301-99, Section 5.3.7 and as described below.
- B. Clean and dampen tie holes and fill solid with patching mortar immediately after form removal. Where plastic plugs have been specified, clean and fill holes in accordance with manufacturer's recommendations.
- C. Do not patch defective concrete and honeycombed areas unless examined and approval is given by Owner's Representative. If the defective concrete is rejected by the Owner's Representative, remove and discard all concrete and replace at no additional cost to the Owner.
- D. If Owner's Representative grants approval to the contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to ensure proper bond thereto. Repairs thicker than one and one-half inches shall be built-up on successive days, each layer of one and one-half inches being applied as described in ACI 301-99, Section 5.3.7. Use specified bonding agent.
- E. Remove and replace patches which become crazed, cracked, or sound hollow upon tapping, at Contractor's expense.

### 3.20 CLEAN-UP

- A. Remove all equipment, unused materials, dirt, rubbish, and debris resulting from the performance of this work. Clean existing surfaces of adjoining work of droppings and where stained by concrete.

## PART 4 - MEASUREMENT AND PAYMENT

## 4.1 METHOD OF MEASUREMENT

- A. Furnishing, installing and removing as applicable all forms, form ties, reinforcing steel and mesh, control joints and expansion joints, inserts, waterstops, anchors, sleeves, bolts, plates and all other miscellaneous items associated with and required for the performance of the Work of this Section will not be measured separately but will be considered incidental to the work of each item.
- B. Item 033000.01 CIP Concrete for Brick Wall Infill will be measured per CUBIC YARD, installed complete-in-place including all labor, materials and equipment required or incidental for the satisfactory completion of the work.
- C. Item 033000.02 CIP Concrete Kneewalls and Piers will be measured per CUBIC YARD, installed complete-in-place including all labor, materials and equipment required or incidental for the satisfactory completion of the work.
- D. Item 033000.03 CIP Concrete Wall Caps will be measured per CUBIC YARD, installed complete-in-place including all labor, materials and equipment required or incidental for the satisfactory completion of the work. Item 033000.02 will be paid for under the work of Section 040305 CONSERVATION TREATMENT OF HISTORIC MASONRY WALLS.
- E. Item 033000.04 CIP Concrete Footings for Bollards will be measured per CUBIC YARD, installed complete-in-place including all labor, materials and equipment required or incidental for the satisfactory completion of the work.
- F. Item 033000.05 CIP Concrete Footings for Light Poles will be measured per CUBIC YARD, installed complete-in-place including all labor, materials and equipment required or incidental for the satisfactory completion of the work.
- G. CIP Concrete for miscellaneous site features will not be measured under the work of this Section but shall be considered incidental to the work of designated other Payment Items specified under other Sections of this Specification.

## 4.2 BASIS OF PAYMENT

- A. The Work measured as provided above will be paid by a payment items. Such price shall constitute full compensation for all labor, materials and equipment required or incidental for the satisfactory completion of the Work as described in this Section.

## 4.3 PAYMENT ITEMS

033000.01	CIP CONCRETE FOR BRICK WALL INFILL	CUBIC YARD
033000.02	CIP CONCRETE KNEEWALLS AND PIERS	CUBIC YARD
033000.03	CIP CONCRETE WALL CAPS	CUBIC YARD
033000.04	CIP CONCRETE FOOTINGS FOR BOLLARDS	CUBIC YARD
033000.05	CIP CONCRETE FOOTINGS FOR LIGHT POLES	CUBIC YARD

END OF SECTION

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